California Secretary of State
Consultant's Report on:

Vote-PAD version 1

Including:
Verification Wand - Version VW1.1
Instruction Assistant Macros - Version 1.1
Vote-PAD Booklet with Sleeves for 8.5 by 14 inch ballots
Grids Sheets for recording write in choices
Braille and Large Print Books of System and Ballot Instructions
Accessories and supplies to create ballot sleeves
Narrator by Telex – Audio Cassette Player
Sony Model TCM-929 as modified by Innovative Rehabilitation Technology, Inc.
Precinct Ballot Scanner by Diebold
Ballot Now by Hart Intercivic

Prepared August 3, 2006
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Scope of Work and Reporting

This report is prepared as a supplement and attachment to the "Staff Review and Analysis" (SOS Report) as prepared by the California Secretary of State's Office of Voting Systems Technology Assessment (OVSTA)

As a part of our consultation and work product, we were asked to provide assistance to OVSTA in planning and conducting voting system tests. The majority of the findings may be reported in the SOS Report. This report will be limited to a description of the system tested, the testing tasks which we conducted, events we observed and findings.

Our expertise is in methodologies for examining computerized voting systems, analysis of systems operation, developing measurements of system compliance with established criteria, identification and analysis of system anomalies, and collecting evidence of system characteristics and compliance. Vote-PAD devices are not computers but as they were presented and tested, and, when used in combination with the marksense paper ballot, they provide the interface between the voter and the computerized voting equipment that will read and tabulate the voters' votes. Accordingly, the Vote-PAD becomes a component of the computerized voting system.

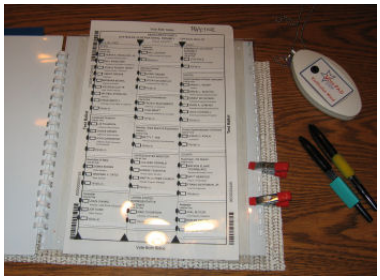
We are not attorneys and do not offer legal advice. We have assisted the California Secretary of State in the collection of facts and evidence that he will use in reaching certification decisions. However, to advise him on the determination of whether the system complies with California's certification requirements would require an interpretation of law. Accordingly, we do not provide recommendations or any opinion as to whether the system can be certified. Recommendations to the Secretary for or against certification are within the duties of the OVSTA and are included in their report.

The work that we have performed and our findings are strictly limited to the specific hardware elements and specific software elements tested during the examination. The results described in this report should be reliable and repeatable for those specific items. The decision to apply those results to decisions about other items is solely at the discretion of and risk of the Secretary of State and the purchasers of systems. Although the content of this report can be used as part of a baseline for reaching conclusions about compliance of other items, users of this report who wish to arrive at such conclusions about compliance of purchased systems or the compliance of a system in use should conduct appropriate acceptance testing or system validation analysis to support those conclusions. If they are do not have a high level of well-founded confidence in their ability to conduct acceptance testing or validation analysis, we strongly recommend that they contract for the assistance of someone with the required knowledge and experience.

Description of System

The Vote-PAD system is comprised of four major voter interface devices designed to be used in tandem with a marksense paper ballot to assist voters in marking the ballot. The four major devices are:

- A Vote-PAD booklet with sleeves. The voter's ballot is held in a clear plastic sleeve inside of a spiral bound or plastic binder notebook. The notebook uses small spring clamps on the covers and pages to make it easier to turn the pages. The ballot sleeve has holes punched in it over the voting target areas on the ballot. Raised grey plastic markers are used to assist in navigation. There is a triangle shaped marker at the top and bottom of each column of vote targets of the ballot and a small oval marker to the left of each vote target on the ballot. Write-in target areas are provided to the right of the write-in mark target for those voters who are capable of writing by hand.

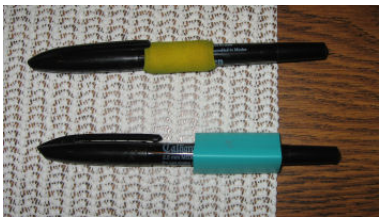


- A verification wand. The wand is designed to detect ink and signal that detection by vibrating. It must be used in a vertical position roughly 30 degrees from plumb. If it is held in the air in no close proximity to anything or at an angle exceeding 30 degrees it will also vibrate. When held vertically over a white surface it does not vibrate. The wand is provided to allow voters to check their ballots and verify that they have made marks in the proper places.

- An audio cassette tape player with two tapes. One tape contains instructions on the use of the system and the other tape instructions for voting a ballot. Two different models of cassette players were tested. One was a Narrator by Telex, the other was a Sony Model TCM-929, as modified by Innovative Rehabilitation Technology, Inc.

- A write-in grid form to allow the voter to use marks to spell out the names of write-in candidates.

Additional elements of the system are:



- Pens with wide grips
- Voter instructions for the system and the ballot in large print and Braille books
- Supplies for preparing the Vote-PAD books and sleeves
- The Instruction Assistant Macros - Version 1.1 which is used to prepare the instructional audio tapes for the system.
- The procedures and user documentation for use of the system

Methodology

The Secretary of State's test plan was designed to evaluate the usability of the Vote-PAD and the effectiveness of the Vote-PAD as an accommodation for voters with disabilities. In our opinion:

The most critical indicator of the usability and effectiveness is the extent to which voters can successfully record their choices in the contests and issues on the ballot. There are two essential elements in the voter's success. The first of these is the extent to which the voter can find and mark the targets for their choices; the second is the extent to which they can follow all the steps necessary to allow their ballot to be accurately counted by the equipment.

The second indicator is the extent to which voters can vote and cast their ballots in a manner which maintains the secrecy of their ballot so that no poll worker, other voters or anyone outside the polling place can determine how they voted.

The third indicator is the level of independence the voter can exercise in casting the ballot. Independence means that the voter does not have to rely upon the assistance of others to cast the ballot. Beyond the relationship of independence and secrecy, a lack of independence has detrimental effects. A voter who is dependent on assistance to vote is at greater risk of being disenfranchised than other voters. Polling places are not often overstaffed, so a voter at a polling place during busy hours may have difficulty getting assistance. The voter who is dependent on assistance may also be limited by the competence of the person providing the assistance. Given the prior two indicators, then the more independence the voter can exercise, the more likely that they will be successful in voting.

The fourth indicator is ease of use. The easier the system is to use, the less likely the occurrence of voter error or abandoning the voting process altogether. Measuring this

indicator is less of an exact science. For voters with motion disabilities, ease of use includes considerations such as the amount of strength and range of motion required for the task of voting. For those with visual impairments, ease of use involves the simplicity of using the senses of hearing and touch to understand the task at hand and to determine if the accomplishment of the task has been successful. For all voters, ease of use includes the difficulty of mentally understanding and navigating through the tasks of voting.

The fifth indicator is the time it takes for a voter to vote. We are well aware that one of the first accommodations which must be provided to voters with disabilities is to allow them whatever time they require to cast their ballot. However, voters have their own limits on the time they are able or willing to commit to the task of voting. An accommodation that takes too long will disenfranchise voters who do not have the time and choose not to vote, or who will limit their voting to what they consider the highest priority contests which they can vote in the time they have available.

The test plan used by the Secretary of State for the Vote-PAD system was designed to capture data on the five elements described above.

The test plan attempted to simulate the experience that a voter would have in a precinct on Election Day and included:

- Participation of voters with a range of disabilities and experience with accessible systems
- Instruction to the voter by a poll worker on how to use the system
- An opportunity for the voter to try voting on a sample or demonstration ballot
- The opportunity to ask for assistance from poll workers during the process of voting
- Using the system to vote and cast a ballot
- An exit questionnaire/interview of the voter at the conclusion of voting
- Observations by a test monitor who recorded the choices the voter said they were making and noted how they actually voted.
- Video taping each voter during the test and the exit interview
- Tabulating the ballots, including the resolution of over votes and canvassing write-in choices according to the standards applied by the counties.

The fifth bullet point listed above required the voter to vote on a two sided single sheet ballot and to vote four write-ins. During the voting process, the voter was twice required to skip a race, continue voting and then go back to the race.

For voters with visual impairments who were willing to participate, a second phase of the testing required them to attempt to determine how pre-marked ballots and write-in sheets had been marked. This was also video taped and results were recorded.

We believe this test plan was a valid methodology for capturing the required data. In addition to the data the video tape captured during testing, it provides evidence that decision makers can use in reaching their decisions on certification. The data captured contains extremes from voters who voted accurately to voters who found the task impossible. The important factors for decision makers to consider in using this data are the overall trends evident in the data. There were changes during testing both in the steps executed by the monitors and in the instructions given by the county employees acting in the role of poll workers. We believe that neither the experience and capability range of the voters or the variations in testing that occurred during the test had any significant effect on the overall outcome of the testing. For those who wish to dispute the validity of the methodology, we suggest a review of the test documents and video tapes of the testing.

Tasks We Performed During the Conduct of Testing

Our tasks during the test included:

- Assisting the OVSTA management and staff with direction of the test.
- Acting as two of the test monitors used by OVSTA to conduct the test.
- Taking many of the photographs used to document the test.
- Conducting the canvass of write-in ballots and resolution of over voted ballots under the direction of county representatives,
- Providing oversight of the tabulation of the ballots by county representatives.

Findings

For our first indicator of usability, the extent to which voters can successfully record their choices in the contests and issues on the ballot, the test data compiled by the Secretary of State shows the following:

- The average rate of invalid votes cast by all voters using the Diebold ballot was 10.0%. With the Hart ballot the rate was 10.7%.

- The average rate of invalid votes cast by four voters with mobility impairments was 0.0% on both systems. All four were able to vote their ballots as intended.

- The average rate of invalid votes cast by voters with dexterity impairments was 5.5% with the Diebold ballot and 4.1% with the Hart ballot. Of the twelve voters in this group, five were able to vote their ballots as intended and seven were not. It should be noted that one voter #129 intentionally made marginal marks on the ballot. However this individual's error rate on a Hart ballot was 7.0%. If these errors were removed from the computation, the error rate with the Hart ballot would be reduced to 3.6% and the number of voters who were not able to cast their votes as intended would be reduced to six.

- The average rate of invalid votes cast by voters with partial vision was 10.3% with the Diebold ballot and 14.3% with the Hart ballot. Of the four voters in this group, none were able to cast their ballots as intended. Two of the four were able to mark the actual ballot in the Vote-PAD sleeve correctly, but were not successful in casting write-ins.

- The average rate of invalid votes cast by blind voters was 17.9% with the Diebold ballot and 21.4% with the Hart ballot. Of the eight voters in this group, none were able to cast the ballot as intended. Among this group, two were able to mark the actual ballot in the Vote-PAD sleeve, but were not successful in casting write-in votes. Only four of the eight attempted to use the write-in grid. None were able to successfully use the grid to cast all the write-ins that they attempted.

- The average rate of invalid votes cast by two voters with developmental disabilities was 66.7 % with the Diebold ballot and 28% with the Hart ballot. The voter with the 66.7% error rate only voted five contests, only two of which were voted as intended.

For our second indicator of usability, the extent to which a voter can vote and cast their ballots in a manner which maintains the secrecy of their ballot, the data compiled by the Secretary of State on responses of voters during the exit interview shows the following:

- Among the 28 voters who responded to the yes or no question of whether this system would allow them to vote in secrecy, 20 said yes and 8 said no. There appeared to be no significant pattern of any relationship between responses and disabilities.

For our third indicator of usability, the level of independence the voter can exercise in casting the ballot, the data compiled by the Secretary of State on responses of voters during the exit interview shows the following:

- Among the 28 voters who responded to the yes or no question of whether this system would allow them to vote independently, 23 said yes and 5 said no. There appeared to be no significant pattern of any relationship between responses and disabilities.

For our fourth indicator of usability, ease of use, the data compiled by the Secretary of State on responses of voters during the exit interview shows the following:

- Among the 28 voters who responded to this question, given a range of responses and scores for each of: Very Easy (5), Somewhat Easy (4), Neutral (3), Somewhat Difficult(2), and Very Difficult(1), There was a somewhat even distribution

weighted slightly heavier towards ease and only two neutral responses. The responses were:

- Six responses of Very Easy
- Nine responses of Somewhat easy
- Two responses of Neutral
- Eight responses of Somewhat Difficult
- Three responses of Very Difficult.

- As with the Privacy and Independence questions, there is nothing that we considered to be a significant relationship between responses and disabilities.

- The Six voters who responded that the system was very easy to use had the following error rates: 0%, 4%, 11%, 24%, 29% and 60%.

- The three voters who responded that the system was very difficult to use had the following error rates: 3%, 4%, and 55%.

For our fifth indicator of usability, the time it takes for a voter to vote, the test data compiled by the Secretary of State shows the following:

- The average time to vote for all voters was 42.2 minutes with the Diebold ballot and 28.2 minutes on the Hart ballot. Times ranged from 6 minutes to 111 minutes.

- The average time to vote for voters with mobility impairments was 11.0 minutes with the Diebold ballot and 9.0 minutes with the Hart ballot. Times ranged from 6 minutes to 17 minutes.

- The average time to vote for voters with dexterity impairments was 20.2 minutes with the Diebold ballot and 23.0 minutes with the Hart ballot. Times ranged from 9 minutes to 47 minutes.

- The average time to vote for voters with partial vision was 80.0 minutes with the Diebold ballot and 33.0 minutes with the Hart ballot. Times ranged from 22 to 96 minutes.

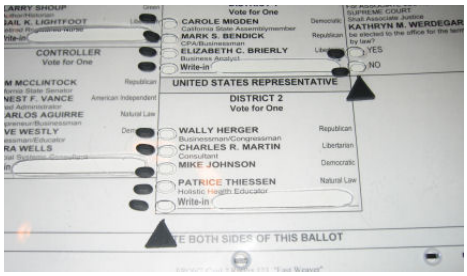
- The average time to vote for blind voters was 77.0 minutes with the Diebold ballot and 40.7 minutes with the Hart ballot. Times ranged from 39 minutes to 111 minutes.

- The average time to vote for voters with developmental disabilities was 36.5 minutes with the Diebold ballot and 30.0 minutes with the Hart ballot. Times ranged from 30 to 48 minutes.

Observations

- The wedge shaped tip on the pens used for marking the ballot made it very difficult for the voters to write a legible candidate name in the target areas for write-ins on the face of the ballot. This was more of a problem for those voters with very limited vision or who were blind because the inability to see their writing made them unaware of the need to hold the pen at an angle that allowed them to write on the ballot legibly.

- Irregular placement of ballot position indicators on the sleeve caused some confusion. This seemed to be more of a problem with the Diebold ballot because it had smaller target areas and less space between candidate names. On the Hart Ballot a vote for two race for City Council, City of Woodland had two write in positions. These two slots had more space between them than the rest of the candidates in the race. This caused some confusion for blind voters who assumed the wider space meant they were moving to the next race on the ballot.



- The system does not offer a solution for matching write-in sheets to ballots while allowing to voter to scan their ballot and benefit from the overvote protection which a precinct mark sense reader can provide. To keep the association between the write-in sheets and the ballot, the sheets must be stapled to the ballot and the ballot deposited in the scanner's emergency bin or into some other form of ballot box. The ballot will then require the canvassing board interpretation of the voter's write-ins and record them on the ballot, separately tabulate them, or duplicate the ballot before tabulation.

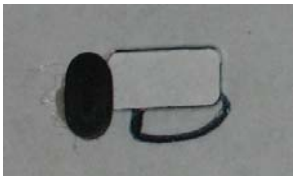
- The system is more difficult to use for left handed voters. The vote position markers for each candidate are on the left of the hole where the mark must be made on the ballot. Right handed voters feel for the marker with fingers on their left hand and hold the pen in their right hand. Left handed voters had to feel for the marks with the right hand holding the pen in the left. This made it difficult for them to ascertain the alignment of the pens with the markers. It was difficult for them to feel the marker with the right hand and place the pen in the hole with the left hand.

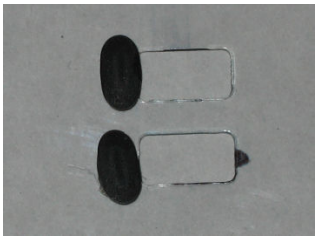
- There is a difference between the sequential number of the races and the instructions to go to the nth race in a column. This caused confusion for some voters. One example can be found on the Hart ballot where the race for Attorney

General is the second race in the second column. For indicating the race on the write-in grid, it is referred to as the sixth race on the ballot.

- Voters in wheel chairs voting on the Diebold scanner found it difficult to insert their ballot into the scanner and make sure that the privacy cover actually covered the ballot.

- Voters who had motion difficulties and blind voters would leave black ink marks on the plastic Vote-PAD sleeve. This presented two problems. First, it indicated which candidate they were attempting to vote for. In addition, the wand would pick up the stray mark on the sleeve and vibrate, which contributed to confusion when they attempted to validate their vote.





- There were a number of false signals available for the wand. The position markers were dark grey and would be picked up by the wand. Unless the ballot was perfectly aligned in the sleeve, the border of the target area could be picked up by the wand. Text on the ballot showing through the sleeve would be picked up. All of these false signals added to voter confusion and probably some of the errors that occurred. Finally, voters tended to get ink on their fingertips. Some would get false reads from ink on their fingertips.

- The system is very sensitive to the thoroughness of poll worker training and their ability to provide instruction and assistance to the voter. Unless the poll worker gives very complete instructions to the voter and is available for follow up questions, the voter can easily fail to complete their ballot consistent with their intent.

- The instructions for the write-in tell the voter to make any mark, such as an X when they find the appropriate cell on the grid. Making an X does not always produce a mark that is wide enough for the wand will pick up. Vote-PAD representatives were not aware that the suggestion of an X as an appropriate mark was in their instructions.

- Voters were not happy about having ink all over their hands.

- The audio script containing the instructions for voting with the Vote-PAD is on cassette tape. The tapes that were tested had no index

markers between races or candidates. Several blind voters commented on the lack of an audio cue on the tape. One voter explained that many audio tapes for the blind use a 60 cycle hum which will sound like a beep at fast forward.

- If a voter is suffering from neuropathy, a loss of feeling in the extremities, they may have difficulty navigating the ballot and locating the holes in the plastic sleeve.

- For voters with motion difficulties, the ballot provided some assistance confining their marks to the target areas on the ballot.

- The voter is dependant on the poll worker to properly align the ballot in the sleeve. The blind or extremely limited vision voter has no way to make sure that the ballot is aligned and that the ballot matches the template. This could allow a poll worker to easily, either by accident or through intent, disenfranchise a voter.

- Using the vote pad with ballots of the length used for the test proved tedious and time consuming for voters. While we are well aware that time for tasks should not be a criteria for accessible devices, for some voters, the time involved in marking this ballot made them very reluctant to spoil the ballot when they realized they had made a mistake. Some voters even declined to review their ballot.

- On the Sony tape player, the speed control was very sensitive and difficult to adjust.

- Voters complained that the write-in grid sheet is not in standard Braille. Unless a voter is proficient in Braille it is difficult to read.

- Voters had difficulty understanding the intended use of the top two rows on the write-in grid. The top row was numbered with a one and the second row was numbered with a two. The concept that the top row positions would be valued as 1 through 30 and the second row would be valued as 31 to 60 was not understood. When they did understand the meaning and values of the spaces, they had difficulty going from a column and race in the column on the ballot to the numeric value of that race and marking the space to denote it on the first two rows of the write-in grid.

- Many voters were either unaware or, during voting, forgot that filling in the target for a write-in vote on the ballot was required in order for their vote to count.

- The raised grey boundaries of the grid would cause the wand to give false readings confusing voters.

- One voter commented that the write-in grid might be easier to navigate if, somehow, the spaces had the value of the letter printed in each space similar to the grids used on some standardized tests. It is difficult to imagine how this would be done.

- Many voters were confused by the blank space between the Braille on the write-in grid and the double bars to the right of that space. Most expected this space to be the first column on the ballot.

- Stray marks that can be read as over votes by the scanner could easily be missed with the wand. This was a higher risk with the Hart ballot because it had larger target areas.

- Voters using the large print books and Braille books appeared to have less trouble navigating the ballot. Probably because it was easier for them to go back and review the booklet than going backwards on the tape. As mentioned above, the lack of indexing on the tape probably contributed to this.

- Voters had difficulty determining which end of the pen they were using.

- Voters attempted to use the wand upside down, which caused it to vibrate even though it was not detecting a mark on the ballot.

Conclusions

Based upon the observations we have cited above and the data compiled by the Secretary of State's office, it is our opinion that for many voters with disabilities, it is a very challenging task to accurately indicate your choices on a mark sense ballot using the Vote-PAD system.

The system seemed to provide the highest level of accommodation for those with motion disabilities and who did not have a visual impairment. The ballot sleeve served to eliminate stray marks outside of the voting targets on the ballot. Although it would still allow stray marks which created over-votes in a race, for these voters it was a decided improvement over voting a plain mark-sense paper ballot.

Voters with severe limited vision or who were blind had a great deal of difficulty casting their ballots. These voters are totally dependant on the performance of the poll worker in giving them the correct ballot and audio tape and for properly aligning the ballot in the Vote-PAD sleeve. They have no ability to verify this task is done correctly and if it is not done correctly they are at risk of being disenfranchised.

Most voters who made an error and then found it were reluctant to spoil a ballot and go back through the process of re-voting a ballot. Whether they would decide to take the effort to make changes in a real election is an open question.

The use of the Write-in Grid sheet was very difficult for voters. Voters complained that the Braille was non standard. most voters had difficulty understanding the use of the top two rows to indicate the office being voted upon. Voters had difficulty determining where the first column on the grid was on the grid. Voters had difficulty going from the ballot to the grid sheet and back again.

Finally, there are comments, both positive and negative which were taken from voters during the exit interview. We believe the voters comments speak for themselves and we have not attempted to analyze them. Since the pool of voters is small we recommend that those comments be reviewed as part of the Secretary of State's process of deciding whether or not to certify the system. We understand that making decisions about the appropriateness of an accommodation for those with disabilities is difficult. Guidance should be taken from the experience of those who have attempted to use the system. The exit interview comments provide an excellent source of that guidance.